UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Docket Nos. 50-329/330

MEMORANDUM FOR: Elinor Adensam, Chief
Licensing Branch No. 4
Division of Licensing

THRU: James P. Knight, Assistant Director
for Components and Structures Engineering
Division of Engineering

FROM: George Lear, Chief
Hydrologic and Geotechnical Engineering Branch
Division of Engineering

SUBJECT: HYDROLOGIC ENGINEERING INPUT TO THE MIDLAND SER

Plant Name: Midland Plant, Units 1 and 2
Licensing Stage: OL
Responsible Branch: Licensing Branch No. 4, R. Hernan, PM
Requested Completion Date: April 6, 1982

Enclosed is our Hydrologic Engineering Input for inclusion in the Safety Evaluation Report for the Midland Plant. This input was prepared by R. Gonzales of the Hydrologic Engineering Section.

There are several outstanding issues which will be addressed in subsequent supplements to the SER. These are:

1) Flood Protection of structures which have settled.

2) Adequacy of Dewatering System - this issue will be addressed in future OM hearings.

3) Ability of Cooling Pond Dikes to withstand the Probable Maximum Flood

A camera-ready copy of Figure 2.4.1 was provided to R. Hernan, the PM, on April 2, 1982.

George Lear

George Lear, Chief
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Enclosure: As stated

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Hydrologic Engineering Summary

Midland Plant

Docket Numbers 50-329/330

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HYDROLOGIC ENGINEERING INPUT TO

THE MIDLAND PLANT UNITS 1 AND 2 SER

DOCKET NUMBERS 50-329 AND 50-330

2.4 HYDROLOGIC ENGINEERING

2.4.1 Introduction

The staff has reviewed the hydrologic engineering aspects of the applicant's design, design criteria and design basis of safety-related facilities for Midland. The acceptance criteria used as a basis for staff evaluations are set forth in Sections 2.4-1 through 2.4-14 of the Standard Review Plan (SRP) NUREG-0800. These acceptance criteria include the applicable General Design Criteria (10 CFR 100), and standards for protection against radiation (10 CFR 20, Appendix B, Table II). Guidelines for implementation of the requirements of the acceptance criteria are provided in Regulatory Guides, ANSI Standards and Branch Technical Positions identified in SRP Sections 2.4-1 through 2.4-14. Conformance to the acceptance criteria provides the bases for concluding that the site and facilities meet the requirements of Parts 20, 50 and 100 of 10 CFR with respect to hydrologic engineering.

2.4.2 Hydrologic Description

The Midland Plant is located directly south of Midland, Michigan, on the southwest bank of the Tittabawassee River. Plant grade is at elevation 634 feet above mean sea level (ft msl), some 43 ft higher than the normal river level. The headwaters of the Tittabawassee River are in north-central Michigan at a point about 65 miles (mi) north of the Midland Plant. From

there it meanders in a southeasterly direction for a distance of about 85 mi until it empties into the Saginaw River. About 22 mi downstream of its confluence with the Tittabawassee, the Saginaw River flows into Lake Huron. The drainage area of the Tittabawassee River above the Midland Plant encompasses about 2400 square miles (mi^2). Figure 2.4.1 shows the drainage basin and other hydrologic features of the Tittabawassee River.

The United States Geological Survey established a stream gaging station, about 4700 ft upstream of the Midland Plant, in March 1936. The maximum flow recorded since then is 34,000 cubic feet per second (cfs) and occurred on March 21, 1948. The maximum known discharge since at least 1907 reached a stage of 610 ft MSL with a peak discharge of 34,800 cfs. This occurred on March 28, 1916. The minimum recorded flow is 39 cfs and the average flow at Midland is about 1650 cfs.

The topography of the Tittabawassee River drainage area lacks pronounced relief and is characterized by lakes and swampy areas. Less than half of the drainage area is forested. There are four existing hydroelectric power plant reservoirs on the Tittabawassee River above the Midland Plant. All of these have dams of earth construction with concrete spillways.

Bullock Creek is a small south side tributary that flows into the Tittabawassee River just upstream of the plant. This stream, which drains an area of about 40 mi^2, had to be rerouted to accommodate construction of the plant fill area.

The applicant provided hydrologic descriptions of the site which the staff reviewed in accordance with procedures in SRP Sections 2.4.1 and 2.4.2. The staff concludes that the information is sufficient and meets the requirements of GDC-2 and 10 CFR Part 100 with respect to general hydrologic descriptions.

2.4.3 Flood Potential

In assessing the flood potential at the site, the applicant analyzed three possible types of flooding: (1) A probable maximum flood (PMF) on the Tittabawassee River with concurrent failure of upstream dams (2) a PMF on Bullock Creek, and (3) flooding due to local probable maximum precipitation (PMP). Flood events considered not applicable to the Midland plant included surge, seiche, tsunami and ice flooding.

The staff reviewed the material presented by the applicant and performed independent evaluations as described in SRP Sections 2.4.2, 2.4.3, 2.4.4, 2.4.5, 2.4.6 and 2.4.7. The staff concludes that the three types of flooding considered by the applicant meet the guidelines of R.G. 1.102 and are the design bases flood events that the Midland Plant must be able to withstand in order to meet the requirements of GDC-2 of Appendix A to 10 CFR Part 50.

2.4.3.1 Probable Maximum Flood on the Tittabawassee River

The PMF is defined as the most severe precipitation induced flood reasonably possible in the region. In Section 3.4 of the SER-CP dated November 12, 1970, the staff tentatively approved of the applicant's computational procedures

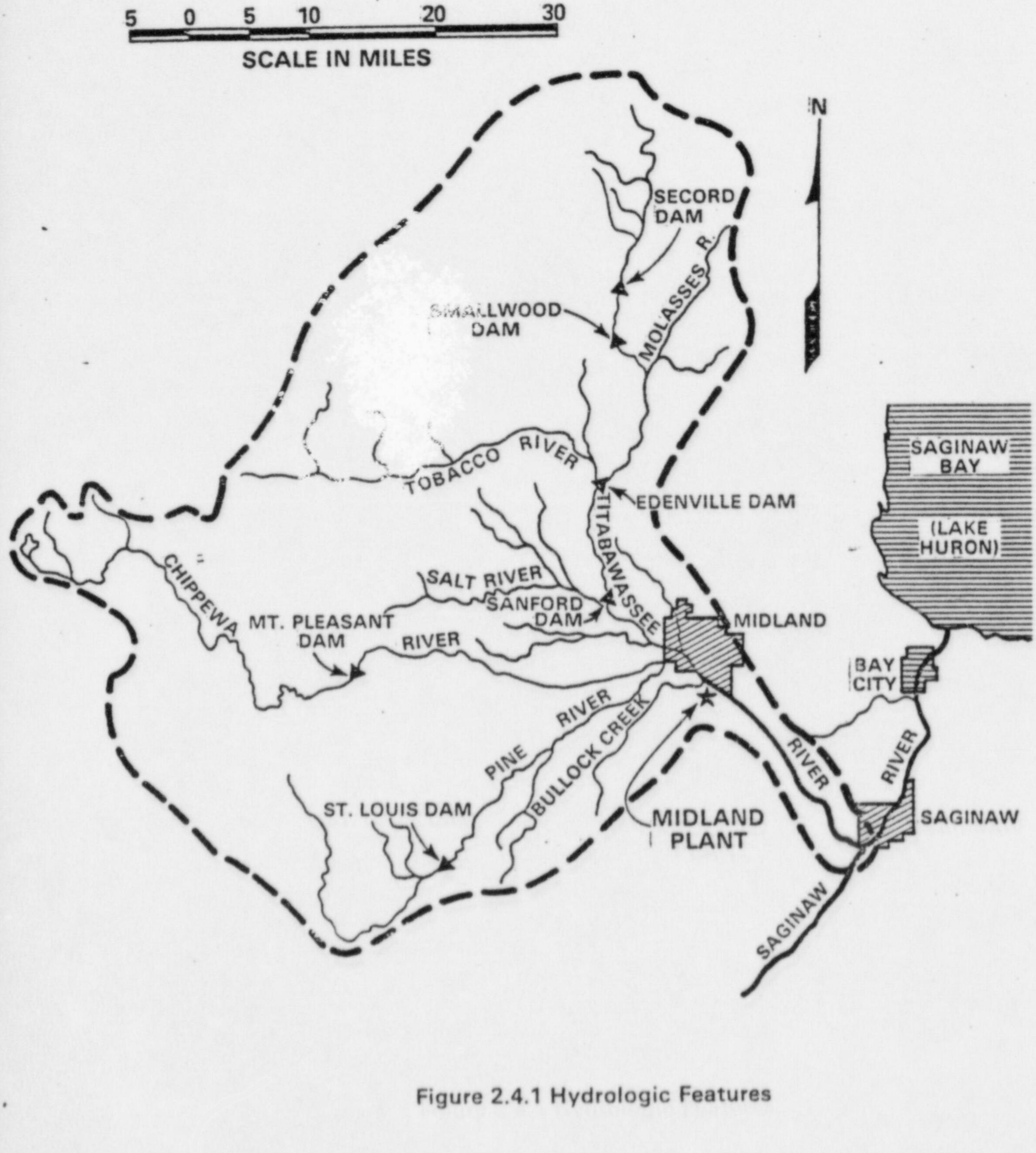

Figure 2.4.1 Hydrologic Features

for determining a PMF at the site and committed to review the applicant's calculation of PMF levels during construction of the plant to assure that computational procedures had been properly employed. Based on our review of the applicant's analyses, we now conclude that the procedures used are appropriate and that hydrologic and hydraulic parameters have been properly evaluated and applied.

For the Tittabawassee River, the applicant estimated a PMF discharge of 248,000 cfs. The effects of failure of the four upstream power dams were then evaluated and the Tittabawassee River PMF was increased to 262,000 cfs to account for this failure. In evaluating failure of the upstream power dams, the applicant assumed that all four dams would be overtopped by a PMF and would fail successively downstream. To allow for this "domino effect," the applicant assumed that the total maximum storage behind all four dams would be concentrated at Sanford Dam which is the furthest downstream and thus closest to the Midland site. It was then assumed that Sanford Dam would be overtopped and that a breach would develop in a low area of the crest of Sanford Dam which would grow progressively due to the erosiveness of the water flowing through the breached section. A dam break hydrograph was developed using the maximum discharge through the failed dam and a volume equal to the total storage of the four failed dams. The resultant dam break flood, with a peak discharge of 210,000 cfs and a volume of 167,000 acre-feet (af), was then routed downstream a distance of about 10 mi to the vicinity of the

Midland Plant. The analysis showed that by the time the dam break flood would arrive at the Midland Plant, its peak would have attenuated from 210,000 cfs to about 60,000 cfs. However, the applicant concluded that the routed dam break flood would peak prior to the main PMF so that only about 14,000 cfs would coincide with the PMF peak of 248,000 cfs at the site. Thus, the total flow in the Tittabawassee river including the effects of dam failures was estimated to be 262,000 cfs. The applicant determined that a discharge of 262,000 cfs, in the Tittabawassee River, would result in a stillwater level of about 630.4 ft msl (rounded off to 631 ft msl) in the vicinity of the plant.

The applicant also determined that because of a constriction in the Tittabawassee River, flood waters would pond just upstream of the plant. Wind blowing across this ponded water could generate waves which could cause water levels to exceed the stillwater level of 631 ft msl. The applicant estimated that wind waves could result in runup levels as high as 635.5 ft msl. Since this is 1.5 ft higher than plant grade, the applicant concluded that openings in safety related structures and components will have to be flood protected to elevation 635.5 ft msl. This is discussed in Section 2.4.4.

The staff has reviewed the analysis presented by the applicant. The criteria used in the staff's review include sections 2.4.2, 2.4.3 and 2.4.4 of the SRP and GDC-2 of Appendix A to 10 CFR Part 50. The staff concludes that the failure mode assumed for Sanford Dam may not be

conservative because the dam could fail in such a manner that the peak of the routed dam failure hydrograph (60,000 cfs) could coincide with the PMF peak of 248,000 cfs. If this were to occur, the peak flow past the plant would be 308,000 cfs instead of the 262,000 cfs determined by the applicant. Using this larger flow, the staff independently determined that a flood of this magnitude would result in a level of about 631.5 ft msl which is 0.5 ft higher than the level determined by the applicant. However, the concurrent wind wave runup calculated by the staff is not as high as determined by the applicant.

The Coastal Engineering Research Center, publisher of the reference used by the applicant to compute wind wave runup, recently revised its method for wave forecasting. Using this new method, the staff estimates that wind wave runup would be about 0.9 ft lower than estimated by the applicant. Thus although a flood of 308,000 cfs would result in a stillwater level about 0.5 ft higher than estimated by the applicant for a discharge of 262,000 cfs, the lower wind wave runup would more than offset the increase in the stillwater level. The staff, therefore, concludes that a maximum flood level of 635.5 ft msl, as computed by the applicant, is conservative and meets the criteria suggested in Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants." The staff further concludes that protection of the plant to elevation 635.5 feet msl will meet the requirements of GDC 2 with respect to floods on the Tittabawassee River.

2.4.3.2 Probable Maximum Flood on Bullock Creek

The applicant developed a PMF on Bullock Creek to determine if this event would result in a higher water level at the plant than the Tittabawassee River PMF level. The Bullock Creek PMF was estimated at 32,600 cfs. Computations were then made to determine the maximum water level which would result, assuming a concurrent 100 year flood in the Tittabawassee River. This analysis showed a water level in Bullock Creek of 620 ft msl. This flood level is lower than the Tittabawassee River PMF level described in Section 2.4.3.1 above.

The staff reviewed the material presented by the applicant and made independent analyses and evaluations. The procedures used by the staff are described in SRP Sections 2.4.2 and 2.4.3. The staff concludes that a flood level estimate of 620 ft msl for a PMF on Bullock Creek is conservative and therefore, is acceptable. The staff further concludes that, with respect to a PMF on Bullock Creek, the Midland Plant meets the requirements of GDC 2.

2.4.3.3 Flooding Due to Local Probable Maximum Precipitation (PMP)

An onsite storm drainage system will convey runoff from a 100 year storm away from the power plant structures. More severe rainfall such as a PMP event will exceed the capacity of the onsite storm drainage system. At the request of the staff, an analysis of the effects of a PMP event on safety related structures and components was made by the applicant. It was conservatively assumed that all storm drains would be blocked

during a PMP event and that there would be no loss of water due to infiltration or retention. This analysis showed that ponded water depths will remain below the lowest door elevations of nearby safety related structures.

The applicant also analyzed the effect of a PMP event on roofs of safety related structures. Ponded PMP levels on building roofs were determined by routing rainfall through parapet openings. This analysis showed that ponding depths on roofs of safety related structures will range from 0.4 ft to about 1.4 ft. (Ponding depths are shown in Q&R Table 2.4-2 of the FSAR). The applicant has stated that building roofs can withstand the loads induced by these estimated ponded water depths.

The staff has reviewed the applicant's analysis using the procedures described in SRP Sections 2.4.2 and 2.4.3. Based on this review, the staff concludes that a local PMP event will not cause water to enter safety related structures. The staff further concludes that during a PMP event, ponded water levels on roofs of safety related structures will remain at or below the levels determined by the applicant.

The staff concludes that with respect to a local PMP, the Midland Plant meets the criteria of Regulatory Guides 1.59 and 1.102 and the requirements of GDC-2.

2.4.4 Flood Protection Requirements

As described in subsection 2.4.3.1, wind waves could result in water levels as high as 635.5 ft msl, 1.5 ft above plant grade elevation of 634 ft msl. Entrances to the auxiliary building are at elevation 634.5 ft msl which is 1 ft lower than the maximum wave runup level. The applicant proposes to protect these entrances by watertight doors or by removable watertight barriers which will be installed before flooding occurs. A technical specification and emergency flood protection procedures will describe the actions to be taken to assure that watertight doors are properly closed and watertight barriers are installed prior to a flood event.

Using the procedures described in SRP Sections 2.4.8 and 2.4.10, the staff has reviewed the flood protection design submitted by the applicant. The staff concludes that the flood protection design for structures whose entrances will be protected by watertight doors or watertight barriers, is acceptable and meets the requirements of GDC-2. The staff has also reviewed the proposed flood protection technical specification. The procedures in SRP section 2.4.14 and 16 were used in this review. The staff concludes the technical specification does not meet the requirement of Section 50.36 of 10 CFR Part 50 because it does not define the conditions under which watertight doors will be closed or watertight barriers will be put in place. Resolution of this item will be described in a supplement to this SER.

Other safety related structures which could be affected by site flooding include the diesel generator building (DGB) and the service water pump structure (SWPS). Entrances to these structures have a design elevation 635 ft, 8 in., which is 3 in. above the maximum calculated water level of waves generated during a PMF. This design is acceptable and meets the requirements of GDC-2. However, both the DGB and the SWPS have experienced some settlement so it is possible that entrances to these structures are no longer above elevation 635.5 ft msl. The staff will require that all entrances to the DGB and the SWPS and any other safety-related structures that may be expected to settle, be at or above 635.5 ft msl or that other engineered features be provided to preclude flooding. All safety-related structures must be flood protected to elevation 635.5 ft msl unless it can be shown that flooding of any structure will not affect the safe operation of the plant. Resolution of this outstanding issue will be provided in a supplement to this SER.

To resist the erosive effects of flood waters in the Tittabawassee River, the outer slopes of the cooling pond dikes are protected with riprap (stone) to the 100 year flood level of 614 ft msl. Seeded turf is provided between this elevation and the top of the dike, elevation 632 ft msl. Although the dike is not classified as a seismic Category I structure, damage or failure of portions of the dike could affect the operability of the emergency cooling water reservoir (ultimate heat sink). Before the staff can complete its flood review as per SRP Section 2.4.8,

the applicant must perform an analysis of the effects of the Tittabawassee River PMF on the cooling pond dikes. If this analysis shows that the dikes will be eroded by flowing water, overtopped or otherwise damaged during the PMF, the applicant must then submit for staff review, the results of its analysis showing what effect damage to the dikes will have on the emergency cooling water reservoir. Resolution of this outstanding issue will also be addressed in a supplement to this SER.

Based on the information provided by the applicant, the staff is unable to determine that flood protection of the Midland Plant cooling pond dikes meets the requirements of GDC-2.

2.4.5 Cooling Water Supply

A cooling pond with a volume of about 12,600 acre feet (af) and a surface area of about 880 acres (ac) has been constructed south of the station. This pond will receive and store water from the Tittabawassee River for use during both normal and emergency operation. To provide a source of emergency cooling water in the event the cooling pond dikes should fail, a secondary or emergency pond has been excavated, below the normal level of the main pond, in the northeast corner of the pond.

The staff has reviewed the material presented by the applicant using the procedures described in SRP 2.4.11 and concludes that the two water sources (the main pond and the emergency pond) meet the guidelines of R.G. 1.27,

"Ultimate Heat Sink for Nuclear Power Plants," with regard to providing a high level of assurance that at least one cooling water source will be available for emergency operation of the plant.

2.4.5.1 Normal Cooling Water Supply

Although the main cooling pond has a volume of 12,600 acre-feet, only about 7,900 acre-feet are considered useable. This volume is sufficient to provide water for full plant operation during a 100 day drought without having to withdraw water from the Tittabawassee River.

Using the procedures described in SRP Section 2.4.11, the staff concludes that the main cooling pond provides a highly reliable source of cooling water such that the emergency pond will be used only on a very infrequent basis. The staff concludes that the requirements of GDC-44 with respect to normal operating conditions have been met.

2.4.5.2 Emergency Cooling Water Supply

The emergency cooling pond provides cooling water for use in the service water system in the unlikely event that the main cooling pond dikes should fail and the main cooling pond should be lost. It is of Seismic Category I design and is excavated in the cold leg of the main cooling pond. It has a normal depth of 8 feet below the bottom of the main cooling pond and a surface area of about 39 ac. The capacity is approximately 1.18×10^7 ft^3 (272 ac-ft) which is sufficient for at least 30 days of cooling.

Emergency cooling water will be withdrawn from a submerged pump bell in the service water pump structure. Heated water will be discharged back to the pond through the service water discharge structures which are located at the south end of the pond. The configuration of the pond, with the withdrawal near the bottom at the north end and the discharge near the surface at the south end, will promote efficient cooling by stratifying the water into hot and cold layers.

The applicant analyzed the ability of the emergency cooling pond to provide a 30-day supply of cooling water for the plant at or below the design basis temperature of 105°F, under the most severe meteorological conditions of record. The applicant's analysis predicted a maximum pond temperature of 105.3°F and a maximum 30 day evaporation of 2.6×10^6 ft^3. Although the predicted temperature exceeds the design basis temperature by 0.3°F, the applicant has stated that due to the short interval that the service water design temperature is exceeded, the design of the emergency cooling pond is considered to meet the criteria of R.G. 1.27, Ultimate Heat Sink for Nuclear Power Plants.

Using the methods discussed in NUREG-0693, "Analysis of Ultimate Heat Sink Cooling Ponds" and NUREG-0733, "Analysis of Ultimate Heat Sink Spray Ponds," and the criteria in R.G. 1.27, the staff also analyzed the performance of the emergency cooling pond. The pond was conservatively modeled as a well mixed pond with a volume of 1.18×10^7 ft^3, rather than

a stratified pond as was assumed by the applicant, in order to account for the possibility of short-circuiting of hot and cool water in the pond which would lead to a lower cooling rate and a higher responsiveness to thermal loads. Meteorological data were taken from Midland-Saginaw, Michigan for the period 1949-1980. The staff predicted that the highest temperature of water withdrawn for the plant would be 98.8^{O}F. The maximum 30 day pond water loss predicted by the staff would be about 1.76 x 10^6 ft^3, which is about 15 percent of the pond volume. The adequacy of the meteorological data base used by the staff was determined by a comparison of the Midland-Saginaw data with onsite data for the years 1975 to 1976. It was determined that the Midland-Saginaw data were more severe for this period than the onsite data, and probably overestimate the pond temperature and water loss by about 0.5^{O}F and 2400 ft^3 respectively.

Both the maximum temperature predicted by the staff and the water lost from the pond were less than those predicted by the applicant. The major reason for the discrepancies between the applicant's and the staff's analyses are:

1. The applicant used more conservative cooling and evaporation formulations in the pond model; and

2. The applicant used the 67 year data base of Lansing Michigan while the staff used the 31 years of data for Midland - Saginaw, Michigan. The Lansing data base is both longer and, according to the applicant, more severe than the Midland-Saginaw data.

Using procedures described in SRP Section 2.4.11, the staff concludes that the emergency cooling pond is capable of supplying a minimum of 30 days of emergency cooling water to the plant at or below the design basis temperature and therefore meets the guidelines of R.G. 1.27, "Ultimate Heat Sink for Nuclear Power Plants" and the requirements of GDC-44.

As described above, water from the emergency cooling pond will be withdrawn by pumps in the service water pump structure (SWPS). Since this structure is located in the cooling pond, it will be subjected to wind wave activity. The applicant calculated the water levels and resulting hydrodynamic loads that could be induced on the SWPS by wind wave runup under extreme conditions. This analysis showed a potential wave runup of about 637 ft msl and a hydrodynamic load of about 4,800 lb per ft. The staff has reviewed the material presented by the applicant and has performed an independent analysis. Based on this, the staff concludes that the applicant's estimate of wave runup and resultant loads is conservative and therefore acceptable. Procedures and guidance discussed in SRP Section 2.4.5 were used by the staff in its review.

The SWPS could also be affected by ice blockage or ice loads so the applicant performed a study to determine what impact ice formation would have on the safe operation of the SWPS.

During normal and emergency operation of the plant, heated water will be discharged into the cooling pond so it is not expected that significant amounts of ice will accumulate at the SWPS. Any surface ice formation in the vicinity of the SWPS would not affect its operation because the water entrance is about 34 ft below the normal water level of the cooling pond. Although significant amounts of ice are not expected to accumulate on the SWPS, the applicant calculated the ice loads that would be induced on the SWPS in the event the plant was not in operation. The applicant states that the SWPS is designed to withstand the ice and static loads that would be induced by a 30 in layer of ice assuming that the cooling pond level is at a normal water level of 627 ft msl.

The staff has reviewed the analysis presented by the applicant. The procedures used by the staff are discussed in section 2.4.7 of the SRP. Based on this review, the staff concludes that ice formation in the vicinity of the SWPS will be minimal at most and will not affect the operation of the SWPS. Thus the staff concludes that the Midland Plant meets the requirement of GDC 2 with respect to icing effects on safety related structures.

In section 10.0 of the SER-CP dated November 12, 1970, the staff stated that the applicant would be required to monitor the pond for silting and if necessary to dredge it periodically. In compliance with this requirement the applicant has proposed a technical specification which defines surveillance requirements and limiting conditions for operation of the pond.

The staff has reviewed the technical specification proposed by the applicant and concludes that the requirements of Section 50.36 of 10 CFR Part 50 have been met with regard to assuring that potential silting of the pond does not impact on its safe operation.

2.4.6 Groundwater

2.4.6.1 Groundwater Description

The Midland Plant is located near the center of the Michigan Basin, a broad, shallow structural basin of Paleozoic sedimentary rocks up to 14,000 ft thick. These rocks are covered by unconsolidated Pleistocene glacial drift that regionally is about 200 to 300 ft thick. The unconsolidated deposits beneath the site have been subdivided into five lithologic units as shown in Table 2.4.7 of the FSAR. There are two groundwater systems located beneath the Midland Plant within these lithologic units; an isolated perched groundwater table in the surficial sands and a deeper confined aquifer. A layer of essentially impervious clay about 150 ft thick separates these two groundwater systems.

The quantity of water in the surficial sands is limited and is not a source of domestic or other supply in the site area. Recharge is mainly by infiltration of precipitation and from streams and ponds. The groundwater gradient in the surficial sands is toward the Tittabawassee River. There are no wells located in the surficial sands between the plant and the Tittabawassee River.

The confined aquifer is not recharged in the site area because of the presence of the thick clay layer that overlies it. The most likely recharge source is from distant areas where the aquifer sand and gravels either outcrop or are connected with other aquifers. In the site area, it is believed that the regional aquifer has a nearly flat gradient sloping generally northeast.

During the site investigation, the applicant inventoried 146 water wells within a 3 mile radius of the plant. All of these wells draw water from the confined aquifer or from a deeper bedrock aquifer. 57 water wells were identified within the site boundaries. Of these, only one has not been sealed. This well is being utilized during construction and will be sealed when construction is complete. In addition, two new construction wells have been installed. These will also be sealed upon completion of construction. Groundwater will not be used by the Midland Plant during operation. There are no present or projected groundwater users within the plant boundaries nor between the plant and the Tittabawassee River.

At the construction permit stage, it was anticipated that the perched groundwater table beneath the plant would rise to a level about equal to that of the cooling pond, elevation 627 ft msl. As expected, this has occurred. However, the applicant now proposed to lower the perched

groundwater level during operation of the plant. Lower groundwater levels are necessary because of the presence of loose sands beneath certain safety-related structures which potentially could liquefy during a Safe Shutdown Earthquake (SSE). An extensive boring program has identified loose sands in the vicinity of the Diesel Generator Building (DGB), the Railroad Bay Area (RBA) of the Auxiliary Building, the Service Water Pipes (SWP) and the Diesel Fuel Tanks (DFT). In the vicinity of the DGB, the RBA and the SWP, loose sands were located in the fill above elevation 610 ft msl. In the vicinity of the DFT, loose sands were located below the foundation mat at approximately elevation 600 ft msl.

The applicant has proposed removal of the loose sands and rebedding of the SWP in the area of the Circulating Water Intake Structure, where this condition exists, to eliminate this problem. The relatively thin layer of loose sand beneath the DFT has been shown to be an isolated pocket and is not considered to present a liquefaction problem. A full discussion on the evaluation of the liquefaction problem will be provided in Section 2.5.4 of a supplement to this SER.

To lower groundwater levels in the vicinity of the DGB and the RBA, the applicant proposes to install a permanent dewatering system. Although elevation 610 ft msl is the maximum design water level underneath these structures during operation of the plant, the applicant proposes to

lower and maintain groundwater levels at or below elevation 595 ft msl beneath the DGB and the RBA. This will allow the plant to continue to operate for some period of time in the event that there is a malfunction of the dewatering system.

2.4.6.2 Design of Dewatering System

In designing the permanent dewatering system, the applicant considered several potential sources which could cause high water levels beneath the plant. Sources considered were: (1) Seepage from the Cooling Pond, (2) flooding in the Tittabawassee River, (3) seepage from Dow Chemical's tertiary treatment pond which is located just west of the Midland Plant and (4) infiltration from precipitation. The staff reviewed the applicant's analyses using the procedures in SRP section 2.4.12 and concludes that these four sources represent all the credible causes of highwater beneath the plant which must be considered in the design of the permanent dewatering system.

The design criteria for cooling pond dike construction called for excavation of a cutoff or inspection trench, along the entire length of the dike. This trench was to fully penetrate the surficial sands into either lacustrine clay or glacial till (see FSAR Figure 2.5-46). Assuming that the dikes were constructed as designed, seepage from the pond should be minimal, except in areas where the cutoff trench is missing, such as adjacent to structures located within the dikes.

To locate areas of recharge from the cooling pond and to determine the hydraulic relationships between the natural and backfill sands, several pumping tests were conducted. These tests showed that seepage from the cooling pond is minimal except in the area surrounding the Circulating Water Intake Structure (CWIS) and the Service Water Pump Structure (SWPS) where water is seeping into the plant fill through the natural and backfill sands.

The staff has reviewed the applicant's submittals and agrees that most of the seepage from the cooling pond is through the sands in the vicinity of the CWIS and the SWPS.

Another source of potential recharge is the Tittabawassee River. However, any potential recharge from this source will be minimized by the plant fill dike which surrounds the plant fill area (see FSAR Figure 2.4-46). The design of this dike is simliar to the cooling pond dikes except in areas where a bentonite slurry trench had to be installed within the dike, because the dike cutoff trench did not penetrate into the impervious materials (FSAR Figures 2.5-46, 2.5-51 and 2.5-52 and figure 24-13 of the 10 CFR 50.54(f) responses).

Normally the water level in the Tittabawassee River is lower than the permanent dewatering design level of 595 feet. The mean annual river elevation is 591.3 feet (see response to 10 CFR 50.54(f) question 24-f). During floods, water levels in the river can rise as high as elevation 631

feet for a Probable Maximum Flood (PMF). However, the duration of a flood of this magnitude is limited. Water levels in the Tittabawassee River for a PMF would remain above elevation 610 feet for only about 6.5 days (see FSAR figure 2.4-23). Because of the limited duration of high water levels and because of the presence of the dike surrounding the plant fill area, the staff concludes that the Tittabawassee River is not a potential source of significant recharge to the plant fill.

Bullock Creek was also considered as a potential source of recharge. However since the bottom of this creek is at elevation 592 feet, which is 3 feet lower than the design level of the permanent dewatering system, it will not be a source of seepage into the plant fill.

The third potential source of recharge that was considered is Dow Chemical's tertiary treatment pond which is located just west of the Midland Plant. The maximum water level in this pond is 614 feet. It is located about 1130 feet west of the plant. Any seepage from this pond, in an easterly direction toward the plant, would be interrupted by the relocated Bullock Creek and would be carried to the Tittabawassee River. (See Figure 52-1 of the 10 CFR 50.54(f) responses). Based on this, the staff concludes that the Dow Pond will not be a source of recharge to the plant fill.

A fourth potential recharge source is infiltration of precipitation. The Midland Plant site will be graded so that runoff from precipitation, or any other source, will not pond to a significant degree. Runoff will

flow into the plant site drainage system which will direct runoff to the Tittabawassee River, Bullock Creek, the cooling pond or to the parking lot which is located southwest of the plant. (See Q&R figure 2.4-2 which was submitted by the applicant in response to NRC safety review question 371.10). This will minimize ponding of water at the site and reduce the amount of water available to infiltrate into the plant fill. The applicant has estimated that two wells have sufficient capacity to pump any water that infiltrates into the ground. These two wells are in addition to the 22 area wells which are also part of the permanent dewatering system which is described below. In its analysis, the applicant assumed that 25% of the average annual precipitation will infiltrate into the ground. The staff does not agree that the applicant's analysis is conservative because rainfall of greater intensity could occur. The probable maximum precipitation (PMP), which is the rainfall for which there is virtually no risk of exceedance, is about 13 inches in a 24 hour period. However, the staff independently determined that even if the entire 13 inches of rainfall were to infiltrate into the plant fill, there is sufficient storage capacity in the plant fill below elevation 610 feet so that even if the area wells did not operate, the infiltrated water would not raise the groundwater level above elevation 610 feet. Based on this very conservative analysis, the staff concludes that infiltration of surface runoff will not be a significant source of recharge.

Design of the permanent dewatering system provides for two subsystems. The first subsystem will consist of a double line of interceptor wells to be located around the Circulating Water Intake Structure (CWIS) and the Service Water Pump Structure (SWPS). The second subsystem will consist of area wells which will be located throughout the plant fill area. In addition to these, numerous permanent observation wells, piezometers and monitoring wells will also be installed throughout the plant fill area.

The applicant has determined that 20 wells are required to intercept and remove the water seeping from the cooling pond. However, to provide nearly uninterrupted service should one or more of the primary interceptor wells break down, a second line of 20 back-up interceptor wells will be installed behind the 20 primary interceptor wells.

In designing the interceptor wells, the applicant initially used a permeability of 31 feet/day. (See 10 CFR 50.54(f) response 24-b). Subsequently the permeability was reduced to 17 feet/day (See 10 CFR 50.54(f) response 47-3). The 31 feet/day was the maximum value determined by the pumping tests. This value was determined from a pumping tests which was conducted to obtain information for design of the temporary dewatering system which was to be installed adjacent to the Unit 2 feedwater isolation valve pit. 17 feet/day was determined from the permanent dewatering pump test performed in well PD-15 which is closer to the seepage source. Tables 24.1, 24.3 and 47.1 of the 10 CFR 50.54(f)

responses list values of permeability which were determined using both field and laboratory tests. Table 47-1 shows two values which are greater than 17 feet/day; however, these values are not for wells located near the source of seepage. They are for wells which are located south of the Diesel Generator Building. Table 24.3 presents permeability values determined from grain size analysis. The highest permeability shown in this table, for a well located in the vicinity of the CWIS and the SWPS is 125 feet/day. Although this value is considerably higher than the 17 ft/day used in design, the staff believes that permeabilities determined from in-situ field tests are much more reliable than laboratory tests based on grain size. This is because soil permeability is influenced not only by grain size but also by soil composition, orientation and distribution of soil particles, void ratio and degree of saturation. An in-situ field test is a better measure of all these parameters than one that considers only grain size. Therefore, the staff concludes that a permeability of 17 feet/day is appropriate for use in design of the permanent dewtering system as outlined in Branch Technical Position HGEB-1 in Section 2.4.12 of the SRP.

The staff has reviewed the applicant's analysis and performed independent evaluations. The staff agrees that 40 wells located as close as possible to the CWIS and the SWPS are sufficient to intercept the seepage from the cooling pond and to provide sufficient redundancy should part of the dewatering system malfunction or fail.

Although the interceptor well system will effectively intercept seepage from the cooling pond, it will not remove all of the water that is already stored in the plant fill. The applicant proposes to accomplish this by installing 24 area wells in the plant fill. Once the groundwater which is already in storage is removed, the area wells will be needed only to maintain groundwater levels at or below 595 ft msl in the vicinity of the Diesel Generator Building and the Railroad Bay area by intercepting any water that is not collected by the interceptor wells or water infiltrating from precipitation and pipe leakage. The staff has reviewed the applicant's analysis and agrees that 24 area wells are sufficient to maintain water levels in the vicinity of the DGB and the RBA below elevation 610 ft msl under normal conditions.

The applicant has stated that the dewatering system is not seismic Category I because it is not required to operate during or after a safe shutdown earthquake. The applicant estimated that in the event of a complete failure of the dewatering system, it would take at least 60 days before water levels below the DGB and the RBA would rise to elevation 610 ft. This would allow sufficient time to repair and/or replace any damaged portion of the dewatering system. To verify this, the staff requested and the applicant conducted a recharge test.

In conducting this test, water levels beneath the DGB were lowered to elevation 595 ft msl. All dewatering well pumps were then turned off and water levels were allowed to rise normally. After 60 days, the highest water level recorded was in the vicinity of the DGB. This level was

elevation 608.95 ft msl. The staff has reviewed the applicant's analysis using SRP Section 2.4.12 and Branch Technical Position HGEB-1. The staff concludes that in the event of a complete failure of the dewatering system, there would be at least 60 days before water levels would rise to elevation 610 ft msl beneath the DGB. Water levels at the RBA would rise more slowly because it is further away from the source of water, the cooling pond.

2.4.6.3 Effects of Pipe Breaks

At the request of the staff, the applicant considered breaks in underground piping and the effects these breaks would have on the ability of the permanent dewatering system to maintain water levels below elevation 610 ft msl in the vicinity of the DGB and RBA. This was done to show compliance with Branch Technical Position HGEB-1 of SRP Section 2.4.12.

Several non-seismic underground circulating water discharge lines are located to the east and west of the DGB, about 18 ft below its base mat. These lines rest on natural sand in which the dewatering system will normally control the groundwater level to elevation 595 ft msl. The applicant performed an analysis of a postulated failure of the 8 ft diameter Unit 2 circulating water discharge line (CWDL) because this is the largest pipe near a critical structure. The applicant in its analysis assumed that the size of the pipe break would be equal to the cross-sectional area of the pipe. The applicant then estimated that the flow rate through this break into the backfill sand would be about 3000 ft^3/day

(16 gpm) and that the predominate flow would be downward through the natural sand on which the pipe is located. The applicant estimated that it would take a maximum of about 3 days, after the pipe break for the groundwater level at the nearest area dewatering well to rise sufficiently above elevation 595 ft msl so that the well pump would activate and begin to pump out the water from the pipe break. Shortly after this, other dewatering wells would also activate and assist in pumping. During the 3-day period between the time the pipe breaks and the nearest well activates, the groundwater level at the edge of the DGB would rise to about elevation 607 ft msl which is 3 ft below the critical elevation of 610' msl. Since the capacity of each area dewatering well is 15 gpm and the maximum flow rate from a pipe break was estimated by the applicant to be about 16 gpm which would disperse in all directions, one well is sufficient to prevent groundwater from rising significantly above elevation 607 ft msl.

The staff has reviewed the applicant's analysis using criteria and procedures from Branch Technical Position HGEB-1 of SRP 2.4.12. The staff concludes that the size of the pipe break assumed by the applicant is conservative and that in the event of a break of this size in the CWDL, which is located about 5 feet east and about 18 feet below the DGB, water levels along the east edge of the DGB could rise to an elevation of about 607 ft msl before area wells would activate and begin removing water from the pipe break. The staff notes that should the area wells be inoperable at the time of a pipe break, water levels beneath the DGB could rise above elevation 607 ft msl. However, were this to occur, the

permanent dewatering monitoring system, which is described in Section 2.4.6.4, would detect the rising groundwater levels and appropriate actions, to be defined in a technical specification, could be taken before groundwater levels rose above elevation 610 ft msl.

The staff notes that the top of the CWDL is at elevation 610 ft msl; therefore, water levels would not be expected to rise significantly above this elevation due to a CWDL pipe break.

Another non-seismic Category pipe analyzed by the applicant for a postulated failure was the condensate storage line (CSL). This line is a 20 in diameter pipe encased in concrete which runs from the condensate storage tank underneath the Diesel Generator Building to the Turbine Building. The condensate storage tank has a maximum capacity of 300,000 gallons. The applicant stated that if the CSL were to break such that the entire 300,000 gallon inventory in the condensate storage tank drained out through the break, and remained only in an area directly beneath the DGB, the resultant groundwater rise would not exceed elevation 610 ft msl even if the area wells did not operate.

The staff has reviewed the applicants analysis using the criteria and procedures in SRP Section 2.4.12 and Branch Technical Position HGEB-1. The staff agrees that a postulated break in the condensate storage line would not result in groundwater levels above elevation 610 ft msl.

The staff concludes that failure of either a Circulating Water Discharge Line or a Condensate Storage Line will not result in groundwater levels above the design level of 610 ft msl. However, the staff will require verification from the applicant that there are no other pipes whose failure could affect the dewatering system's ability to maintain water levels below elevation 610 ft msl beneath safety-related structures.

2.4.6.4 Dewatering Monitoring Program

The applicant has proposed a monitoring system consisting of six monitoring wells with continuous recorders and warning devices, 28 observation wells and four piezometers. The monitoring wells will be located at strategic locations; two at the Diesel Generator Building, two at the Auxiliary Building and two in the Circulating Water Intake Structure/Service Water Pump Structure area. These monitoring wells will be inspected on a weekly basis to verify the operation of the recording and warning systems. The observation wells and piezometers will be located throughout the plant fill area.

The staff has reviewed the applicant's analysis and the locations of the monitoring wells, observation wells and piezometers. The staff is unable to determine whether the monitoring system is adequate to detect any unexpected rise in groundwater levels because the applicant has not identified the extent of the areas to be dewatered to elevation 595 ft msl. The applicant has been requested to provide a dewatering control plan which

will identify the specific areas to be dewatered to elevation 595 ft msl and the monitoring wells and/or piezometers which will be used to assure that this level is maintained. Resolution of this issue will be presented in a supplement to this SER.

A technical specification will describe procedures to be taken in the event that water levels exceed elevation 595 ft msl in the areas to be dewatered to this elevation. Although this technical specification has not been submitted for staff review, the applicant has provided a description of the items to be addressed. The staff has reviewed the applicant's submittal and concludes that in addition to the items already described, the technical specification must also define the maximum elevations to which water levels in the dewatered areas will be allowed to rise above elevation 595 ft msl before plant shutdown is initiated. In addition, the technical specification must also identify the specific wells (dewatering, monitoring, and/or observation) and piezometers which will be used to determine this shutdown elevation.

The staff cannot conclude that the proposed dewatering monitoring system meets the criteria of Branch Technical Position HGEB-1 of SRP 2.4.12 or the requirements of Section 50.36 of 10 CFR Part 50.

2.4.6.5 Design Basis for Subsurface Hydrostatic Loading

All safety-related structures, systems and components have been designed to withstand the hydrostatic loadings which would result from water levels as high as the Probable Maximum Flood as described in Section 2.4.3.1. Since this water level is higher than any present or potential groundwater level the staff concludes that the applicable criteria of SRP Section 2.4.12 and the requirements of GDC-2, with respect to subsurface hydrostatic loadings, have been met.

2.4.7 Accidental Releases of Liquid Effluents in Ground and Surface Water

SRP Section 2.4.13 sets forth criteria and procedures for the analysis of accidental releases of liquid effluents in ground and surface waters. Using these, the staff analyzed postulated failures of the Boron Recovery System Receiver Tank and the Boric Acid Concentrate Tank to determine the potential for radioactive contamination of surface and ground water supplies. As described in Section 15.7.3, these tanks were selected for analysis because they contain the highest potential concentrations.

The Boron Recovery System Receiver Tank is located in the auxiliary building about 50 feet below plant grade. A failure of this tank would result in contaminants spilling out into the auxiliary building. In order for contaminants to leak out of the auxiliary building, there would have to be cracks in the auxiliary building floor or exterior walls. It is highly unlikely that there would be cracks in the auxiliary building large

enough to allow significant water leakage because the auxiliary building is of seismic Category I design. However, if there were large cracks, and no action was taken to clean up the liquid spill, contaminants would leak out into the clay strata underneath the auxiliary building. This clay is essentially impervious and is about 150 ft thick so it is highly unlikely that the underlying confined aquifer would be affected. To verify this, the staff performed an analysis assuming that the entire inventory of the Boron Recovery System Receiver Tank enters the groundwater regime. This analysis showed that concentrations of all nuclides at the nearest water well would be less than one percent of the limits shown in Table II of Appendix B in 10 CFR Part 20.

The Boric Acid Concentrate Tank is located in the auxiliary building at elevation 634.6 ft msl which is just above a plant grade elevation of 634 ft msl. Failure of this tank would result in a liquid spill which could run out on the plant yard through the railroad bay area. The plant onsite drainage system would intercept the spill and route it to the cooling pond. After being diluted in the cooling pond, the spill would enter the Tittabawassee River in the plant blowdown if no actions were taken to intercept contaminated water. The staff's analysis showed that the concentration of all nuclides in the Tittabawassee River resulting from an assumed Boric Acid Concentrate Tank spill would also be less than one percent of the limits shown in Table II of Appendix B in 10 CFR Part 20.

Based on these analyses, the staff concludes that postulated accidental spills of radioactive liquids will not result in concentrations above 10 CFR Part 20 limits for any surface or groundwater supply. Thus the requirements of 10 CFR Part 100 with respect to potential surface and groundwater contamination have been met by the Midland Plant.

2.4 References

U.S. Army Corps of Engineers, Coastal Engineering Research Center, "Coastal Engineering Technical Note CETN-I-6, Revised Method for Wave Forecasting in Shallow Water," March 1981.

AFW Draft from Bill LeFave & Dave Fisher 4/9/82

feed ring-type feedwater waterhammer experienced in recirculating type steam generators. Therefore, this generic item does not apply to Midland. Therefore, the guidelines of BTP ASB 10-2 "Design Guidelines for Water Hammers in Steam Generators with Top Feedring Designs," do not apply and the requirements of GDC 4 with respect to dynamic effects associated with fluid flow instabilities are met. ~~Based on its review of the main feedwater system, the staff concludes that the system's design is in accordance with the guidelines of Regulatory Guides 1.26 and 1.29 and the requirements of GDC 2, 4, 5, 44, 45, and 46. The staff, therefore, concludes that the system is acceptable.~~

INSERT "O" →

10.4.9 Auxiliary Feedwater System

~~The following section is the staff's evaluation of the Midland auxiliary feedwater system (AFWS). This evaluation is presented in two parts: Part I is the evaluation of the AFWS against the criteria of the SRP. Part II is the evaluation of the AFWS against the criteria developed after the TMI-2 accident, which are enumerated in the NRC generic letter of April 24, 1980 and identified as Item II.E.1.1 of NUREG-0660 and NUREG-0737.~~

~~10.4.9.1 Acceptance Criteria~~ STET

The staff reviewed the Midland auxiliary feedwater system against the acceptance criteria of SRP Section 10.4.9. These criteria are: GDC 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, ~~tornadoes, hurricanes, and floods~~; [INSERT 10.4-1] GDC 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks; [INSERT 10.4-2] GDC 5, as related to the capability of shared systems and components important to safety to perform required safety functions; GDC 19, as related to the design capability of system instrumentation and controls for prompt hot shutdown of the reactor and potential capability for subsequent cold shutdown; [INSERT 10.4-3] GDCs 34 + 44, to ensure (1) the capability to transfer heat loads from the reactor system to a heat sink under both normal operating and accident conditions, (2) redundancy of components so that under accident conditions the safety function can be performed assuming a single active component failure (this may be coincident with the loss of offsite power for certain events), [INSERT 10.4-4] and (3) the capability to isolate components, subsystems, or piping if required so that the system

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INSERT "P"

safety function will be maintained; GDC 45, as related to design provisions made to permit periodic inservice inspection of system components and equipment; GDC 46, as related to design provisions made to permit appropriate functional testing of the system and components to ensure structural integrity and leaktightness, operability, and performance of active components, and capability of the integrated system to function as intended during normal, shutdown, and accident conditions. INSERT 10.4-5 ~~Regulatory Guides 1.26, as related to the quality group classification of system components; 1.29, as related to the seismic design classification of systems components; 1.62, as related to design provisions made for manual initiation of each protective action; 1.102, as related to the protection of structures, systems, and components important to safety from the effects of flooding; 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles; and BTPs ASB 3-1, as related to breaks in high and moderate energy piping systems outside containment; and ASB 10-1, as related to auxiliary feedwater pump drive and power supply diversity.~~

The following evaluation discusses the implementation of the above acceptance criteria and follows the format of the review procedures identified in SRP (NUREG-0800) Section 10.4.9. ~~The staff review is based on information contained in FSAR Section 10.4.9 and Appendix 10A and on a walkdown of the AFWS during a site visit on April 30, 1981.~~ This evaluation also includes our review of the applicant's response to Item II.E.1.1, "Auxiliary Feedwater System Reliability," of NUREG-0737, "Clarification of The TMI Action Plan Requirements." This includes:

INSERT "Q" →

The AFWS is designed to supply an independent source of water to the steam generators during normal plant startup, shutdown, and layup operations and in the event of a loss of main feedwater supply (see Figure 10.5). The major components of the Midland AFWS are two 100-percent-capacity essential safety-grade pumps, one steam turbine driven and one motor driven. Both pumps function in a transient or accident condition, but only the motor-driven pump is used during plant startup or normal plant cooldown. The normal AFWS water supply is provided by the condensate storage tank. The deaerator storage tanks or the condenser hotwell may also be used to supply water to the AFWS during hot standby or normal plant cooldown. A seismic Category I makeup supply (automatically initiated on low suction pressure) to the auxiliary pump suction is provided by the service water system in the event that the condensate storage tank or other sources of water are not available. ← INSERT "R"

INSERT O

Based on our review of the condensate and feedwater system, we conclude that the system meets the requirements of General Design Criteria 2, 4, 44, 45 and 46 as they relate to protection against natural phenomena, missile and environmental effects (including water hammer), decay heat removal function, inservice inspection and testing. The system also meets the guidelines of Regulatory Guide 1.29 with respect to seismic classification. We, therefore, conclude that the system is acceptable.

INSERT 10.4-1

Acceptability is based on meeting Position C.1 of Regulatory Guide 1.29 for safety-related portions of the system and Position C.2 for nonsafety-related portions. Protection against other natural phenomena is evaluated in Section 3.4 (flooding) and 3.5 (missiles) of this SER;

INSERT 10.4.2

The basis for acceptance for meeting this criterion is set forth in Sections 3.5 and 3.6 of this SER.

INSERT 10.4-3

Acceptability is based on meeting BTP RSB 5-1, "Design Requirements of the Residual Heat Removal System," with regards to cold shutdown from the control room using only safe grade equipment.

INSERT 10.4-4

BTP ASB 10-1, "Design Guidelines for Auxiliary Feedwater System Pump Drive and Power Supply Diversity for Pressurized Water Reactors" shall be used in meeting these criteria.

INSERT 10.4-5

In meeting this criterion the plant Technical Specifications should specify that the monthly AFW system pump test shall be performed for each AFW pump on a staggered test basis.

INSERT P

In meeting these criteria, the recommendations of NUREG-0611, "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in Westinghouse-Designed Operating Plants," and NUREG-0635, "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in Combustion Engineering-Designed Operating Plants," shall also be met. An acceptable AFWS should have an unreliability in the range of 10^{-4} to 10^{-5} per demand based on an analysis using methods and date presented in NUREG-0611 and NUREG-0635. Compensating factors such as other methods of accomplishing the safety functions of the AFWS or other reliable methods for cooling the reactor core during abnormal conditions may be considered to justify a larger unavailability of the AFWS.

INSERT Q

1. An evaluation against the generic recommendations of NUREG-0611 and 0635.

2. The evaluation of system reliability based on the applicant's reliability study.

3. An evaluation of the design basis for the flow capability for the system.

INSERT R

With the exception of the emergency (Class 1E) power supply to the essential motor driven AFW pump, the AFWS is not shared between units and, therefore, the requirements of General Design Criterion 5 are not applicable. The power supply sharing is discussed further in this SER section. Acceptability of the power supply sharing is discussed in Section 8.3 of this SER.

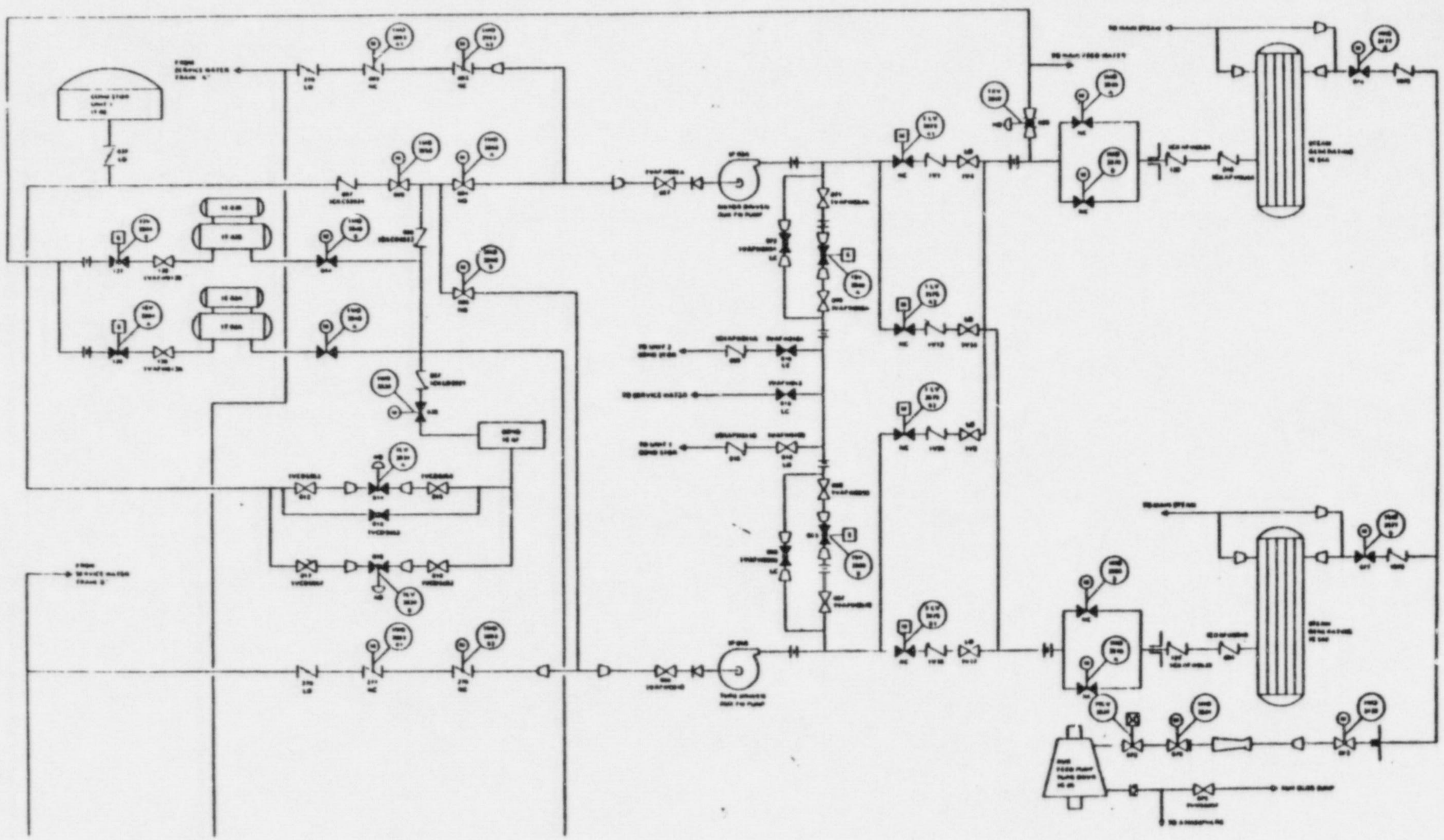

Figure 10.4-1 Midland Auxiliary Feedwater Double Crossover Design

~~10.4.9.1.1 Operating Characteristics, Classification, and Inservice Testing~~ STET

STET

we have

~~The staff has~~ reviewed the FSAR to verify the acceptability of the AFWS design with respect to its operating characteristics, classification, and provisions for inservice inspection and functional testing.

Minimum performance requirements for the AFWS have been identified and are NOT sufficient for the various functions of the system. This is discussed in more detail in the following paragraphs of this section of the report.

The AFW pumps take emergency suction from two sources. The normal source is the nonseismic Category I condensate storage tank (CST). If the CST is unavailable because of a tornado or seismic event, the operator is notified by low pressure alarms on the pump suction, and an automatic switchover to the seismic Category I tornado-protected service water system (SWS) occurs. One service water train supplies each AFW pump. Upon initiation of service water, the affected train(s) is (are) automatically isolated by power-operated valves from the nonseismic Category I piping leading to the CST, condenser hotwell, and deaerator storage tank. Check valves are also provided to prevent backflow to the CST, condenser hotwell, and deaerators.

Each SWS train is isolated from the other SWS train by redundant seismic Category I motor-operated valves powered from separate essential busses so that a single failure of one AFW train does not affect the other. A normally closed, fail close, seismic Category I power-operated valve is provided in the crosstie between the main feedwater system and the AFW motor-driven pump train.

The above features provide sufficient isolation to ensure that system function is not impaired in the event of a failure of a nonessential component. Based on the above, the staff concludes that the system meets the isolation requirements of GDC 2, 44 and the guidelines of Position C.2 of Regulatory Guide 1.29.

The essential portions of the AFWS are designed to seismic Category I requirements and Quality Group C requirements up to the containment isolation valves, and with Quality Group B specifications from the upstream side of these valves to the steam generators. Based on the above, the staff concludes

that the AFWS meets the requirements of GDC 2 and safety standards of Regulatory Guides 1.26 and 1.29 with respect to quality group and seismic classification.

AFWS testing and inspection are included in the system design. Each AFWS pump is equipped with a recirculation line to the condensate storage tank for periodic functional testing purposes. Periodic testing of the AFWS pumps and valves is identified in the plant Technical Specifications. Based on the above, the staff concludes that the system meets the requirements of GDC 46 with respect to functional testing.

The AFWS components are located in accessible areas to permit periodic inservice inspection in accordance with ASME Code Section XI. Based on this, the staff concludes that the system meets the requirements of GDC 45 regarding design provisions for inservice inspection.

10.4.9.1.2 Natural Phenomena, Pipe Breaks, and Cracks

The staff has reviewed the AFWS design for protection against the effects of natural phenomena, pipe breaks, or cracks in fluid systems outside containment, single system component failures, loss of an onsite motive power source, or loss of offsite power.

Protection against failure of nonseismic Category I plant features is provided. Failure of nonseismic Category I systems, components, or structures will not adversely affect AFWS function. All essential AFWS components are located in seismic Category I structures and are provided with protection against failure of nonseismic Category I components. Therefore, the staff concludes that the AFWS design meets the requirements of GDC 2 with respect to protection against the effects of earthquakes because the safety-related portions are designed to seismic Category I requirements in accordance with Position C.1 of Regulatory Guide 1.29 and the nonsafety-related portions are designed in accordance with Position C.2 of Regulatory Guide 1.29.

Protection against missiles, tornadoes, and floods is provided. Essential portions of the AFWS are located in the tornado-missile-and-flood-proof

auxiliary building. The normal water supply provided by the condensate storage tank, deaerator storage tank, or the condenser hotwell are not tornado-missile protected. In the event of the loss of the normal nontornado-protected water source, the suction of the AFWS would be automatically transferred to the tornado-protected service water system upon low pump suction pressure coincident with the presence of an AFW actuation signal. The essential components of each AFWS train are housed in separate compartments which provide protection against internally generated missiles. (See Sections 3.4.1, 3.5.1.1, and 9.3.3 of this report for further discussion.) The staff concludes that the AFWS is protected from floods, tornadoes, and missiles and meets the requirements of GDC 2 and 4 and the guidelines of Regulatory Guides 1.102 and 1.117.

The essential AFWS trains may be used during startup and shutdown; therefore, they are designed as high-energy lines, and pipe breaks were postulated in the AFWS. Protection against high-energy pipe breaks in the AFWS is provided by separation of equipment. Essential portions of the AFWS are protected against the effects of high- and moderate-energy line breaks in other systems. These include the effects of pipe whip, jet impingement, and flooding. High-energy piping systems are not located in the area of essential AFWS components. (See Section 3.6.1 of this report for further discussion of protection against the effects of pipe breaks.) Environmental qualification with respect to pipe breaks is discussed in Section 3.11 of this SER. The essential components of each AFWS train are housed in separate watertight compartments for internal flood protection. Valves are installed in the floor drain lines for each essential AFWS pump room to prevent backflooding of the rooms. The staff concludes that the essential portions of the AFWS are protected against the effects of pipe whip, jet impingement, and flooding associated with pipe breaks and meet the requirements of GDC 4 and the guidelines of BTP 3-1 with respect to pipe breaks outside containment.

For either normal operating or accident conditions, the AFWS is designed to provide sufficient feedwater to the steam generators to transfer the reactor coolant system decay heat to the main condenser or, if the condenser is unavailable, to the atmosphere through the atmospheric dump valves or the power-operated atmospheric vent valves.

INSERT 10.4-6

The Technical Specifications require that with one AFW pump and associated flowpath inoperable that the inoperable system be restored to operable within 72 hours or be in hot shutdown within the next 12 hours. The system is tested monthly on a staggered test basis to assure both pumps are operable and that each valve is in its correct position. At least once per 18 months, during shutdown, the automatic features of the system are verified operable including pump starts, valve operation and level control. The motor driven pump is used for plant startup, such that a separate flow verification test of the AFW system following an extended cold shutdown is not required (GS-6 of NUREG-0611 and NUREG-0635). An independent operator will perform valve lineup checks following testing or maintenance in addition to the valve lineup check made according to procedures for returning the system to service following maintenance or testing. This meets the guidelines of Recommendation GS-6 of NUREGs-0611 and 0635 with respect to flow path verification and independent operator valve lineup checks.

INSERT 10.4.7

In the event of failure of the nontornado-protected, nonseismic Category I condensate-quality water sources, transfer to the seismic Category I service water system occurs automatically on low pump suction pressure. [We required the applicant to verify by test or analyses that AFW pump damage would not occur during the switchover interval due to the temporary loss of NPSH. Resolution of this item is currently under review by the applicant and we will report our evaluation of the resolution in a supplement to this SER. In the meantime, we cannot conclude that the requirements of GDC 2 and the recommendations of NUREGs 0611 and 0635 are met with respect to protection against natural phenomena and protection of the pumps due to loss of suction pressure.]

The heat transfer path from the steam generators under this condition is from the power operated atmospheric relief valves to the atmosphere. (Refer to Section 10.3.1 for further discussion.)

The AFWS can function automatically as required in the event of a loss of offsite power. The turbine-driven pump receives main steam from both steam generators through a dc-powered motor-operated valve on each steam supply line. These valves are normally closed and open on receipt of an auxiliary feedwater actuation signal (AFWAS). The steam supply lines are located upstream of the main steam isolation valves. The AFWS pump turbine exhausts to atmosphere. The turbine-driven and motor-driven pump level control valves are ac powered through inverters from the dc bus, normally closed, and open on receipt of an AFWAS. The motor-driven pump can be powered from an onsite diesel generator vital ac bus. Each auxiliary feedwater pump discharge header is isolated from the steam generator it feeds by a vital ac-motor-operated valve in parallel with a dc-motor-operated bypass valve.

The AFWS consists of two trains, one supplying each steam generator. As indicated above, the AFWS trains are powered from redundant and diverse sources in accordance with BTP ASB 10-1.

The AFW pump discharge headers are provided with a double crossover piping arrangement for system redundancy. Each crossover line contains a normally closed power-operated valve. If either AFW train fails to supply the necessary feedwater to its associated steam generator, the AFW pump of the other train would then supply feedwater via the crossover piping.

Double isolation of main feedwater from the AFWS during normal operation is provided. Steam supply to the turbine-driven pump is provided from both steam generators through separate dc-powered motor-operated valves. Redundant isolation is provided for all essential portions of the AFWS from nonessential portions and systems.

Automatic AFWS function is provided in the event of a main steamline or main feedwater line rupture. The AFWS is equipped with a redundant feed-only-good generator (FOGG) interlock system that operates to automatically isolate flow to a faulted steam generator and automatically direct flow to the intact steam generator. The steam generator with the break is detected by measuring the pressure difference between the two steam generators. When the pressure

difference exceeds a set point, AFW is terminated to the low pressure steam generator. In this manner, only one steam generator will be isolated such that isolation of both steam generators if both are at low pressure is avoided. (Refer to Sections 7.3 thru 7.5 for a further discussion of the FOGG system.) Each AFWS pump is designed to provide 100 percent of the flow necessary for decay heat removal over the entire range of reactor operation, including all postulated design-basis accidents. A minimum of 175,000 gal of water in the condensate storage tank for each unit is reserved by Technical Specifications. This volume adequately accommodates the plant at hot standby for approximately 4 hours followed by a 6-hour cooldown to 280°F (decay heat removal system cut-in temperature). The safety-related water supply (service water) is a long-term source of water that is considered inexhaustible for AFWS functions.

The staff has recently determined reliability safety goals necessary for an AFWs to be acceptable with respect to GDC 44. As set forth in SRP Section 10.4.9, for an AFWS to have adequate heat transfer capability and component redundancy, the system must have an unreliability in the range of 10^{-4} to 10^{-5} per demand. As discussed in further detail below, the Midland AFWS unreliability is unacceptably high. Therefore, to meet the requirements of GDC 44, the staff required that the applicant provide, for each unit, a third pump of AFW that is capable of providing at least the minimum flow necessary to the steam generators for decay heat removal during a loss of offsite power or improvements to the present system design or other existing systems to meet our requirements. ~~The staff will report resolution of this matter in a supplement to this SER.~~ This is discussed in further detail below. INSERT 10.4-8

The turbine-driven dc-powered AFWS pump train provides a diverse means of ensuring feedwater supply to the steam generators independent of all offsite or onsite ac power sources for 2 hours. The turbine-driven pump bearings do not require cooling from an ac-dependent source, and the pump can operate without area forced ventilation for the 2-hour period. Actuation and control of this train are provided from the vital dc power source. Based on the above, the staff concludes that the system meets the power diversity position of BTP ASB 10-1 and the power diversity recommendations of NUREG-0611 & 0635.

INSERT 10.4-8

The turbine-driven and motor-driven AFW pumps automatically start ~~upon~~ within 40 seconds from the receipt of a signal ~~from~~ from the safety-grade AFWAS. Following AFW actuation, control of steam generator level is accomplished using automatic AFW control valves in each AFW loop. Control signals for each AFW level control valve are supplied by redundant and independent Class 1E level transmitters on the associated steam generators. In

INSERT 10.4-8

AFWAS is initiated by any of several possible signal inputs: low pressure in either steam generator, a low water level in either steam generator, a reactor building high-pressure signal, loss of three out of four reactor coolant pumps, loss of both main feed pumps, a Class 1E undervoltage, presence of an emergency core cooling actuation signal (ECCAS), or a manual trip.

addition to automatic initiation, AFW equipment may be manually actuated from the control room or from the auxiliary shutdown panel. Based on the above, the staff concludes that the system design provides instrumentation and control for prompt initiation of a shutdown, in accordance with the requirements of GDC 19 and the guidelines of BTP RSB 5-1 and the recommendations of NUREG-0611 + 0635 with respects to initiation and control. (Refer to Sections 7.3 thru 7.5 for further discussion of actuation and control). Manual capability to initiate and control the AFWS pumps and valves and to isolate either AFWS train is provided in the control room and in the auxiliary shutdown panel. Based on this, the staff concludes that the system meets the manual initiation provisions of Regulatory Guide 1.62.

The AFWS for each unit is completely independently from the AFWS for the other unit except for the backup secondary water source provided by the safety-grade service water system (SWS). Although the SWS is shared between units, it contains two redundant independent trains. Each SWS train is capable of simultaneously supplying the emergency feedwater requirements of both units. Therefore, a failure of one train of the SWS will not prevent the safe shutdown and cooldown of either unit. Based on the above, the staff concludes that the AFWS meets the requirements of GDC 5 with respect to sharing of structures, systems, and components.

Conclusion

The auxiliary feedwater system includes all components and equipment from the CST (including valves and cross connections) up to and including the connections with the steam generators. Based on the review of the applicant's proposed design criteria, design bases, and safety classification for the auxiliary feedwater system, and system performance requirements during normal, abnormal, and accident conditions, the staff concludes that the design of the auxiliary feedwater system and supporting systems is in conformance with the Commission's regulations as set forth in GDC 2, 4, 5, 19, 45, and 46, and meets the guidelines in Regulatory Guides 1.26, 1.29, 1.62, and 1.117, and BTPs ASB 10-1 and ASB 3-1.

~~As discussed above, the Midland AFWS is not acceptable with respect to GDC 44. The staff will report on the resolution of this matter in a supplement to this SER.~~

10.4.9.2 Auxiliary Feedwater System Reliability Review

The staff has reviewed the Midland Units 1 and 2 AFWS against the requirements of the April 24, 1980 NRC generic letter dated, which corresponds to Item II.E.1.1 of NUREG-0660 and NUREG-0737.

10.4.9.2.1 Introduction and Background

The TMI-2 accident and subsequent investigations and studies highlighted the importance of the AFWS in the mitigation of transients and accidents. As part of its assessment of the TMI-2 accident and related implications for operating plants, the staff evaluated the AFWS for all operating plants having a NSSS designed by Westinghouse (NUREG-0611) or Combustion Engineering (NUREG-0635). The staff evaluations of these system designs are in the respective NUREGs, along with the staff's recommendations for each plant and the concerns that led to each of the recommendations. The objectives of the evaluation were to: (1) identify necessary changes in AFWS design or related procedures at the operating facilities to ensure the continued safe operation of these plants, and (2) to identify other system characteristics of the AFWS that, on a long-term basis, may require system modifications. To accomplish these objectives, the staff

(1) reviewed plant-specific AFWS designs against the SRP

(2) assessed the relative reliability of the AFWS under various loss of feedwater transients (one of which was the initiating event of TMI-2) and other postulated failure conditions by determining the potential for AFWS failure as a result of common causes, single point vulnerabilities, and human error.

In accordance with the requirements of Item II.E.1.1 of NUREG-0660, the staff has applied the generic results and recommendations from the above described reviews for operating plants to the Midland AFWS and has reviewed the detailed

Midland AFWS reliability evaluation submitted by the applicant. Although NUREG-0611 and 0635 were for Westinghouse and Combustion plants the generic short and long term recommendations were evaluated for the Midland plant in accordance with NUREG-0800, SRP Section 10.4.9. The staff evaluation of this reliability analysis follows. [illegible]

In a letter dated February 23, 1981, the applicant provided a report entitled "Midland Plant Auxiliary Feedwater System Reliability Analysis." This analysis evaluated the AFWS reliability for the three postulated transients and accident scenarios identified for study in the staff's April 24, 1980 letter utilizing fault-tree methodology. Overall numerical system unavailability for the three cases was determined using the NRC-approved provided failure rate data base. Results of the applicant's analysis indicated that the Midland AFWS ranked in the medium reliability range for case 1, Loss of Main Feedwater; for case 2, Loss of Offsite Power; and for case 3, Loss of All AC Power. This ranking is based upon a comparison of the results of reliability assessments of the AFWS designs in all operating PWRs. AFWS unreliability in the medium range, 10^{-3} to 10^{-4} per demand, is not in accordance with the licensing criteria in SRP Section 10.4.9. An AFWS should have an unreliability in the range of 10^{-4} to 10^{-5} per demand in order to be acceptable with respect to the heat transfer and redundancy requirements of GDC 44. Therefore, the staff required that the applicant provide for each unit a third AFW pump that is capable of providing at least the minimum flow necessary to the steam generators for decay heat removal during a loss of offsite power condition, or provide other means for decay heat removal or design changes to the AFWS to bring the system to the high range. The staff will complete its evaluation of this matter in a supplement to this SER.

Insert 10.4-9 →

The staff has reviewed the applicant's deterministic comparison of the Midland AFWS against SRP Section 10.4.9 and BTP ASB 10-1 and finds that the AFWS design is in compliance, except with respect to GDC 44, as discussed above. Environmental qualification of the AFWS is discussed in Section 3.11 of this SER.

Short-term recommendations GS-2, GS-5, GS-7, GS-8, and GL-1 in the staff's April 24, 1980 letter were not included in this evaluation because they either do not apply or are covered by the long-term recommendations included in this SER.

The staff has reviewed the applicant's response to the requirement in Enclosure 2 of the staff's April 24, 1980 letter regarding the design basis for AFWS flow requirements. The applicant provided this information in Revision 33 to the FSAR.

The staff concludes that the applicant's design basis for AFWS flow requirements is acceptable.

The staff concludes that the implementation of the recommendations identified from the above reviews has improved the reliability of the Midland AFWS, although, as noted above, the reliability of the Midland AFWS is not considered adequate. The applicant will incorporate all applicable short- and long-term recommendations of the April 24, 1980 letter prior to receipt of the operating license.

10.4.9.2.2 Implementation of Staff Recommendations

Short-Term Recommendations

Recommendation GS-1

> The licensee should propose modifications to the Technical Specifications to limit the time that one AFW system pump and its associated flow train and essential instrumentation can be inoperable. The outage time limit and subsequent action time should be as required in current Technical Specifications; i.e., 72 hours and 12 hours, respectively.

In response, the applicant indicated in FSAR Appendix 10A.3 that the proposed Midland Technical Specification, Section 3.7.1.2, applies. This Specification limits plant operation with one AFWS train out of service to 72 hours and the subsequent action time to 12 hours. The staff concludes that this Technical Specification is in compliance with its recommendation and is, therefore, acceptable.

Recommendation GS-3

> The licensee has stated that it throttles AFW system flow to avoid water hammer. The licensee should reexamine the practice of throttling AFW system flow to avoid water hammer. The licensee should verify that the AFW system will supply on demand sufficient

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By letter dated March 1, 1982, the applicant provided a revised reliability study for the AFWS that placed the Midland system in the high range of 10^{-4} to 10^{-5} unreliability. The revised study was based on three major proposed changes in the AFWS design and Technical Specifications. These are: The motor driven pump would have the capability to be powered from both emergency buses; the limiting conditions for operation in the plant Technical Specifications would be changed such that one AFWS pump could only be out for 48 hours in lieu of 72 hours before shutdown begins; the basic criterion for the reliability study was changed of core uncovery to allow time for manual actions. [We have reviewed the applicant's proposed changes and conclude they are not an acceptable alternative to a third AFW pump. This conclusion is based on the possible reduction in overall reliability of the emergency buses due to the cross-connect feature and a reduction of the defense-in-depth goal by not using steam generator dryout as a basic criterion for the AFW system reliability analyses. Based on the above we conclude that the AFW system is not in compliance with GDC 44 with respect to heat transfer capability and redundancy.]

initial flow to the necessary steam generators to assure adequate decay heat removal following loss of main feedwater flow and a reactor trip from 100 percent power. In cases where this reevaluation results in an increase in initial AFW system flow, the licensee should provide sufficient information to demonstrate that the required initial AFW system flow will not result in plant damage due to water hammer.

In response, the applicant indicated in FSAR Appendix 10A.3 that the Midland AFWS does not rely on throttling of AFW flow for protection against waterhammer.

Based on the applicant's response, the staff concludes that Recommendation GS-3 is not applicable to Midland. (Also, refer to Section 10.4.7 of this SER)

Recommendation GS-4

Emergency procedures for transferring to alternate sources of AFW supply should be available to the plant operators. These procedures should include criteria to inform the operator when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

(1) The case in which the primary water supply is not initially available. The procedures for this case should include any operator actions required to protect the AFW system pumps against self-damage before water flow is initiated.

(2) The case in which the primary water supply is being depleted. The procedures for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply.

In FSAR Appendix 10A.3 the applicant indicated that an automatic transfer of the AFWS water supply from the condensate storage tank to the service water system is provided. The automatic transfer occurs on a low pump suction pressure signal coincident with the presence of an AFWAS. Therefore, it is not

necessary to have emergency procedures for transferring to alternate sources of AFW supply for the case in which the primary water supply is not initially available, although procedures will be available as discussed in Part 2 below. The staff finds the response to Part 1 of this recommendation acceptable.

By letter dated June 4, 1981, the applicant indicated that the condensate storage tank low level alarm response procedure will provide for manual switchover to alternate suction sources. The alarm response procedure will be issued prior to plant operation. The staff finds the response to Part 2 of this recommendation acceptable.

Recommendation GS-6

> The licensee should confirm flow path availability of an AFW system flow train that has been out of service to perform periodic testing or maintenance as follows:
>
> (1) Procedures should be implemented to require an operator to determine that the AFW system valves are properly aligned and a second operator to independently verify that the valves are properly aligned.
>
> (2) The licensee should propose Technical Specifications to assure that prior to plant startup following an extended cold shutdown, a flow test would be performed to verify the normal flow path from the primary AFW system water source to the steam generators. The flow test should be conducted with AFW system valves in their normal alignment.

By letter dated June 4, 1981, the applicant stated that Midland maintenance and test procedures require that valves be returned to their original position upon completion of maintenance or surveillance testing. Technical Specification 4.7.1.2.a.3 will be revised to require second independent valve lineup verification following maintenance or testing of the AFWS. The staff finds the applicant's response to this part of the recommendation acceptable, pending issuance of the Technical Specifications. ~~by DL~~.

By letter dated June 4, 1981, the applicant stated that Technical Specification 4.7.1.2 will be revised to require a flow path test every 18 months or after an extended cold shutdown. Extended cold shutdown will be defined as a cold shutdown equal to or greater than 30 days. The Technical Specification will also specify the flow path as condensate storage tank to both steam generators through the AFW nozzles using the motor-driven AFW pump. Verification will be by AFW flow indication and steam generator level. The Technical Specification will be revised prior to plant operation. The staff finds the applicant's response to this part of the recommendation acceptable pending issuance of the Technical Specifications.

Additional Short Term Recommendations

Recommendation

> The licensee should provide redundant level indication and low level alarms in the control room for the AFW system primary water supply, to allow the operator to anticipate the need to make up water or transfer to an alternate water supply and prevent a low pump suction pressure condition from occurring. The low level alarm setpoint should allow at least 20 minutes for operator action, assuming that the largest capacity AFW pump is operating.

By letter dated June 4, 1981, the applicant stated that a low level alarm is provided to warn the operator that the CST is approaching the minimum AFW volume required for a safe shutdown. A low level alarm will be provided from the plant computer to give the operator at least 20 minutes to assess the need for makeup water or transfer to an alternate water supply. The staff finds the response to this recommendation acceptable.

Recommendation (This recommendation has been revised from the original recommendation in our April 24, 1980 letter.)

> The licensee should perform a 48-hour endurance test on all AFW system pumps, if such a test or continuous period of operation has not been accomplished to date. Following the 48-hour pump run, the pumps

should be shut down and cooled down and then restarted and run for 1 hour. Test acceptance criteria should include demonstrating that the pumps remain within design limits with respect to bearing/bearing oil temperatures and vibration and that pump room ambient conditions (temperature, humidity) do not exceed environmental qualification limits for safety-related equipment in the room.

In FSAR Appendix 10A.3 the applicant committed to perform a 48-hour endurance test on all AFWS pumps during startup testing. The applicant should document the results of the tests and include the following:

(1) a brief description of the test method and instrumentation used

(2) a plot of bearing and bearing oil temperature vs time for each pump demonstrating that the temperature design limits were not exceeded

(3) a plot of pump room ambient temperature and humidity vs time to demonstrate that the pump room ambient conditiosn do not exceed environmental qualification limits for safety-related equipment in the room

(4) a statement confirming that the pump vibration limits were not exceeded

The staff concludes that the response to this recommendation is acceptable pending receipt of acceptable test results. If the results are not acceptable, the staff will require modifications and provide a safety evaluation regarding the tests and modifications.

Recommendation

The licensee should implement the following requirements as specified by Item 2.1.7.b on page A-32 of NUREG-0578: "Safety-grade indication of auxiliary feedwater flow to each steam generator shall be provided in the control room. The auxiliary feedwater flow instrument channels shall be powered from the emergency buses

consistent with satisfying the emergency power diversity requirements for the auxiliary feedwater system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9."

In Appendix FSAR 10A.3 the applicant responded to this recommendation by stating that safety-grade flow indication of AFWS flow to each steam generator is provided. This response is evaluated in Section 7.3 of this SER.

Recommendation

Licensees with plants which require local manual realignment of valves to conduct periodic tests on one AFW system train, ~~and there is~~ with only one remaining AFW train available for operation should propose Technical Specifications to provide that a dedicated individual who is in communication with the control room be stationed at the manual valves. Upon instruction from the control room, this operator would realign the valves in the AFW system train from the test mode to their operational alignment.

By letter dated June 4, 1981, the applicant stated that the Midland Technical specifications require two AFW trains to be operable for modes 1, 2, and 3. During surveillance testing in modes 1, 2, and 3, which requires local manual realignment of valves, an individual assigned to the test who is in communication with the control room will be stationed at the manual valves. Upon instruction from the control room, this operator would realign the valves in the AFWS from the test mode to the operational mode. The staff finds the response to this recommendation acceptable.

Long-Term Recommendations

Recommendation GL-2

Licensees with plant designs in which all (primary and alternate) water supplies to the AFW systems pass through valves in a single flow path should install redundant parallel flow paths (piping and valves).

Licensees with plants in which the primary AFW system water supply passes through valves in a single flow path, but the alternate AFW system water supplies connect to the AFW system pump suction piping downstream of the above valve(s), should install redundant valves parallel to the above valve(s) or provide automatic opening of the valve(s) from the alternate water supply upon low pump suction pressure.

The licensee should propose Technical Specifications to incorporate appropriate periodic inspections to verify the valve positions.

At the Midland plant, the normal AFW source is the CST. Water from this tank passes through valves in a single flow path ~~which~~ that subsequently divides and supplies suction to each AFW pump. Downstream of these valves in the primary water source flow path, each AFW pump is provided with a separate supply line with double isolation valves from the secondary water source. The valves between the secondary water supply and the AFW pump suction open automatically upon a low pump suction pressure signal coincident with the ~~present~~ presence of an AFWAS. The Midland Technical Specifications also provide for periodic inspections to verify the AFWS valve positions. The staff finds the response to this recommendation acceptable.

<u>Recommendation GL-3</u>

"At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate AFW system flow and be capable of being operated independently of any AC power source for at least two hours. Conversion of DC power to AC power is acceptable."

The FSAR indicates that the turbine-driven AFW pump and its associated flow path and essential instrumentation automatically initiate AFWS flow and are capable of being operated independent of any ac power source for at least 2 hours. The staff has reviewed this information and confirms that the turbine-driven AFWS pump train is available to supply emergency feedwater independent

of onsite or offsite ac power supplies. Based on its review, the staff concludes that this recommendation is satisfied by the Midland AFWS design.

Recommendation GL-4

> Licensees having plants with unprotected normal AFW system water supplies should evaluate the design of their AFW systems to determine if automatic protection of the pumps is necessary following a seismic event or a tornado. The time available before pump damage, the alarms and indications available to the control room operator, and the time necessary for assessing the problem and taking action should be considered in determining whether operator action can be relied on to prevent pump damage. Consideration should be given to providing pump protection by means such as automatic switchover of the pump suctions to the alternate safety-grade source of water, automatic pump trips on low suction pressure, or upgrading the normal source of water to meet seismic Category I and tornado protection requirements.

At the Midland plant the normal AFW source is nonsafety grade. The safety-grade source is provided by the SWS to the suction of each AFW pump. Switchover of the AFW pump suction to the SWS is accomplished automatically using a two-out-of-four low pump suction pressure logic concurrent with the presence of an AFWAS. To prevent spurious opening of the service water valves as a result of normal transients, the low suction pressure must persist for 4 seconds before it initiates opening of these valves. Approximately 2.5 seconds is required for valves to reach the 50-percent-open position, which is the point at which full flow will be established. The staff requires that the applicant ensure that the AFW pumps can survive the low suction pressure condition for the approximately 7 seconds required to effect the water source transfer.

In a meeting with the applicant on April 30, 1981, the staff requested that the applicant evaluate the need for installing a low suction pressure pump trip to protect the AFW pumps in the event that the normal (nonseismic, nontornado) water source is lost while the AFWs is operating in a manual mode (that is, pumps running without the presence of an auxiliary feedwater

actuation signal). ~~The staff will report resolution of the response to this recommendation in a supplement to this SER.~~ In Revision 39 to the FSAR the applicant provided redundant low pressure trips for each pump when the pump is in the manual mode. In the presence of an AFWAS these trips are overridden.

Recommendation GL-5

The licensee should upgrade the AFW system automatic initiation signals and circuits to meet safety-grade requirements.

In response to this recommendation, the applicant indicated in FSAR Appendix 10A.3 that the present AFW automatic initiation signals and circuits are safety grade. The evaluation of the design is in Section 7.3 of this SER.

[The staff will provide resolution of the pump protection during automatic switchover to the SWS in a supplement to this report.]

10.4.9.3 Conclusions

Based on its review the staff concludes that the AFW system meets the requirements of General Design Criteria 2, 4, 5, 19, 34, 45 and 46, with respect to protection against natural phenomena, missiles and environmental effects, shared systems, operational capability from the control room, inservice inspection and functional testing, the guidelines of Regulatory Guide 1.29 and BTPs ASB 10-1 and RSB 5-1 concerning seismic classification, power diversity and design of decay heat removal systems, and the recommendations of NUREGs-0611 and 0635, concerning generic improvements to the AFW system design, procedures and technical specification. [However, the staff cannot conclude that the AFW system meets the requirements of GDC 44 with respect to system reliability since the two pump design does not meet the unavailability criterion of (10^{-4} - 10^{-5} per demand) of SRP Section 10.4.9. We therefore conclude that the system is unacceptable, require the applicant to install a third pump to meet the unavailability criterion. We will provide resolution of this item in a supplement to this report.